

What is claimed is:

1. A method of treating a solid substrate, the method comprising:

- (I) providing a solid substrate;
- 5 (II) spraying the solid substrate with an aqueous solution of at least one material capable of reacting at or near the solid substrate surface selected from a group consisting of (i) reactive silanes, (ii) reactive siloxanes, (iii) hydrolysis products of (i), (iv) hydrolysis products of (ii), and (v), combinations of any of (i), (ii), (iii), and (iv), and essentially, immediately thereafter,
- 10 (III) spraying the solid substrate from (II) with a silicon-containing material capable of reacting at or near the solid substrate surface selected from the group consisting of : a. materials containing multi-silanol groups,
 - b. siliconates,
 - c. silicates, and,
 - d. any combinations of a., b., and c.
- 15

20

25

30

2. A method of treating a solid substrate, the method comprising:

(I) providing a solid substrate;

(II) immersing the solid substrate in an aqueous solution of a at least one material capable of reacting at or near the solid substrate surface selected from a group consisting of (i) reactive silanes, (ii) reactive siloxanes, (iii) hydrolysis products of (i), (iv) hydrolysis products of (ii), and (v), combinations of any of (i), (ii), (iii), and (iv), and essentially, immediately thereafter,

(III) dipping the solid substrate from (II) in a silicon-containing material capable of reacting at or near the solid substrate surface selected from the group consisting of : a. materials containing multi-silanol groups, e. siliconates, f. silicates, and, g. any combinations of a., b., and c.

15 3. A method of treating a solid substrate, the method comprising:

(I) providing a solid substrate;

(II) spraying the solid substrate with an aqueous solution of a at least one material capable of reacting at or near the solid substrate surface selected from a group consisting of (i) reactive silanes, (ii) reactive siloxanes, (iii) hydrolysis products of (i), (iv) hydrolysis products of (ii), and (v), combinations of any of (i), (ii), (iii), and (iv), while essentially simultaneously

(III) spraying the solid substrate from (II) with a silicon-containing material capable of reacting at or near the solid substrate surface selected from the group consisting of : a. materials containing multi-silanol groups, b. siliconates, c. silicates, and, d. any combinations of a., b., and c.

25 4. A method as claimed in claim 1 wherein the aqueous solution in (II) also contains a material having a dianion.

30 5. A method as claimed in claim 2 wherein the aqueous solution in (II) also contains a material having a dianion.

6. A method as claimed in claim 3 wherein the aqueous solution in (II) also contains a material having a dianion.
7. A method as claimed in claim 1 wherein there is in addition, a treatment enhancer present for the reaction of (III).
- 5 8. A method as claimed in claim 2 wherein there is in addition, a treatment enhancer present for the reaction of (III).
9. A method as claimed in claim 3 wherein there is in addition, a catalyst present for the reaction of (III).
10. The method as claimed in claim 1 wherein the silicon-containing material is a silane.
- 10 11. The method as claimed in claim 10 wherein the silane is an organofunctional silane.
12. The method as claimed in claim 2 wherein the silicon-containing material is a silane.
13. The method as claimed in claim 12 wherein the silane is an organofunctional silane.
14. The method as claimed in claim 3 wherein the silicon-containing material is a silane.
- 15 15. The method as claimed in claim 14 wherein the silane is an organofunctional silane.
16. The method as claimed in claim 1 wherein the silicon-containing material is an alkoxy functional silane.
17. The method as claimed in claim 16 wherein the silane is an aminoorganofunctional silane.
18. The method as claimed in claim 17 wherein the aminoorganofunctional silane has the
- 20 general formula:



wherein n has a value of 1, 2, or 3; x has a value of 1 to 20; R is an alkyl group having 1 to 6 carbon atoms; each R^2 is hydrogen or an alkyl group selected from the group consisting of 1 to 6 carbon atoms, X is a halogen, each R^3 is hydrogen or an alkyl group selected from the group consisting of 1 to twenty carbon atoms and b has a value of 0, 1, 2, or 3.

- 25 19. The method as claimed in claim 18 wherein R is a methyl radical, n has a value of 3, x has a value of 3, each R^2 is a methyl group.

20. The method as claimed in claim 1 wherein the solid substrate is selected from the group consisting of:

- a. cotton,
- b. polyester,
- c. nylon,
- d. rayon,
- e. rubber,
- f. fibers,
- g. acrylic,
- h. foams,
- i. polypropylene,
- j. polyethylene,
- k. mineral,
- l. polyurethane,
- m. paper,
- n. glass,
- o. silica,
- p. wood,
- q. concrete,
- r. other solid polymers,
- s. other hard surfaces, and
- t. building products.

21. The method as claimed in claim 16 wherein the alkoxy silane is trimethoxysilane.

10 22. The method as claimed in claim 2 wherein the silicon-containing material is an alkoxy functional silane.

23. The method as claimed in claim 22 wherein the silane is an aminoorganofunctional silane.

24. The method as claimed in claim 23 wherein the aminoorganofunctional silane has the

15 general formula:



wherein n has a value of 1, 2, or 3; x has a value of 1 to 20; R is an alkyl group having 1 to 6 carbon atoms; each R^2 is hydrogen or an alkyl group selected from the group consisting of 1 to 6 carbon atoms, X is a halogen, each R^3 is hydrogen or an alkyl group

20 selected from the group consisting of 1 to twenty carbon atoms and b has a value of 0, 1, 2, or 3.

25. The method as claimed in claim 24 wherein R is a methyl radical, n has a value of 3, x has a value of 3, each R^2 is a methyl group.

26. The method as claimed in claim 2 wherein the solid substrate is selected from the

25 group consisting of:

- a. cotton,
- b. polyester,
- c. nylon,
- d. rayon,
- e. rubber,
- f. fibers,
- g. acrylic,
- h. foams,
- i. polypropylene,
- j. polyethylene,
- k. mineral,
- l. polyurethane,
- m. paper,
- n. glass,
- o. silica,
- p. wood,
- q. concrete,
- r. other solid polymers,
- s. other hard surfaces, and
- t. building products.

27. The method as claimed in claim 22 wherein the alkoxy silane is trimethoxysilane.
28. The method as claimed in claim 3 wherein the silicon-containing material is an alkoxy functional silane.
29. The method as claimed in claim 28 wherein the silane is an aminoorganofunctional silane.
30. The method as claimed in claim 29 wherein the aminoorganofunctional silane has the general formula:



wherein n has a value of 1, 2, or 3; x has a value of 1 to 20; R is an alkyl group having 1 to 6 carbon atoms; each R^2 is hydrogen or an alkyl group selected from the group consisting of 1 to 6 carbon atoms, X is a halogen, each R^3 is hydrogen or an alkyl group selected from the group consisting of 1 to twenty carbon atoms and b has a value of 0, 1, 2, or 3.

31. The method as claimed in claim 30 wherein R is a methyl radical, n has a value of 3, x has a value of 3, each R^2 is a methyl group.

32. The method as claimed in claim 3 wherein the solid substrate is selected from the group consisting of:

20 a. cotton, b. polyester, c. nylon, d. rayon,
e. rubber, f. fibers, g. acrylic, h. foams,
i. polypropylene, j. polyethylene, k. mineral, l. polyurethane,
m. paper, n. glass, o. silica, p. wood,
q. concrete, r. other solid polymers, s. other hard surfaces, and
t. building products.

33. The method as claimed in claim 28 wherein the alkoxy silane is trimethoxysilane.

25 34. The method as claimed in claim 1 wherein the silicon-containing material is an oligomer siloxane.

35. The method as claimed in claim 1 wherein the silicon-containing material is a polymeric siloxane.

36. The method as claimed in claim 1 wherein the silicon-containing material is a

30 disilane.

37. The method as claimed in claim 1 wherein the silicon-containing material contains an $-\text{Si}(\text{C})_y\text{Si}-$ linkage.
38. The method as claimed in claim 37 wherein y has a value of from 1 to 12.
39. The method as claimed in claim 1 wherein the silicon-containing material is a
5 silicone/organic copolymer.
40. A solid substrate when treated by the method of claim 1.
41. The method as claimed in claim 2 wherein the silicon-containing material is an oligomer siloxane.
42. The method as claimed in claim 2 wherein the silicon-containing material is a
10 polymeric siloxane.
43. The method as claimed in claim 2 wherein the silicon-containing material is a disilane.
44. The method as claimed in claim 2 wherein the silicon-containing material contains an $-\text{Si}(\text{C})_y\text{Si}-$ linkage.
- 15 45. The method as claimed in claim 44 wherein y has a value of from 1 to 12.
46. The method as claimed in claim 2 wherein the silicon-containing material is a silicone/organic copolymer.
47. A solid substrate when treated by the method of claim 2.
48. The method as claimed in claim 3 wherein the silicon-containing material is an
20 oligomeric siloxane.
49. The method as claimed in claim 3 wherein the silicon-containing material is a polymeric siloxane.
50. The method as claimed in claim 3 wherein the silicon-containing material is a disilane.
- 25 51. The method as claimed in claim 3 wherein the silicon-containing material contains an $-\text{Si}(\text{C})_y\text{Si}-$ linkage.
52. The method as claimed in claim 51 wherein y has a value of from 1 to 12.
53. The method as claimed in claim 3 wherein the silicon-containing material is a silicone/organic copolymer.
- 30 54. A solid substrate when treated by the method of claim 3.